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Research Paper

A Mindfulness Breast Care App to reduce body image distress and stigma for breast cancer survivors: Development and preliminary quality assessment

Shuang Zheng^{a, b, 1}, Wenhe Huang^{c, d, e, 1}, Xueqin Zhang^f, Ying Hua^a, Sally Chan^g, Shengjie Liu^{a, h}, Yujing Zhong^a, Xiaoying Jiangⁱ, Jiemin Zhu^{j, *}^a School of Medicine, Xiamen University, Xiamen, China^b Department of Nuclear Medicine, General Hospital of Central Theater Command, Wuhan, China^c Cancer Centre and Department of Breast and Thyroid Surgery, Xiang'an Hospital, Xiamen University, Xiamen, China^d Fujian Key Laboratory of Precision Diagnosis and Treatment in Breast Cancer, Xiang'an Hospital, Xiamen University, Xiamen, China^e Xiamen Research Centre of Clinical Medicine in Breast & Thyroid Cancers, Xiamen University, Xiamen, China^f Department of Obstetrics, Women and Child's Hospital, School of Medicine, Xiamen University, Xiamen, China^g President Office, Tung Wah College, Hong Kong, China^h Department of Thyroid and Breast Surgery, Weifang People's Hospital, The First Affiliated Hospital of Weifang Medical University, Weifang, Chinaⁱ School of Nursing, Fujian Medical University, Fuzhou, China^j Department of Nursing, Women and Children's Hospital, School of Medicine, Xiamen University, Xiamen, China

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ABSTRACT

Objectives: This study aimed to develop and preliminarily assess the quality of a Mindfulness Breast Care (MBC) App to reduce body image distress and stigma among breast cancer survivors (BCSs).

Methods: The development process of the MBC App involved: 1) establishing a research group; 2) determining of the content of the MBC App based on Mindfulness-Based Cognitive Therapy and 3) technical exploitation and maintenance. A mixed-methods study was conducted. We selected ten BCSs by a convenience sampling method. After using the APP for three months, five assessed the quality using the Mobile App Rating Scale: User Version (uMARS) and another five were interviewed for process evaluation.

Results: The MBC App was developed with three modules: 1) Library to provide health education information on body image, stigma, mindfulness, recovery and etc; 2) Mindfulness Yoga to offer 12 Hatha yoga videos for daily practice; and 3) Mindfulness Practices to have 12 sessions of mindfulness video-conferences. Based on the uMARS data, the MBC App received high ratings for functionality (4.10 ± 0.34), aesthetics (3.93 ± 0.55), information quality (4.10 ± 0.72), and perceived impact (4.03 ± 0.96), as well as moderate ratings for engagement (3.72 ± 0.94) and subjective quality (3.87 ± 0.77). Participants indicated that the MBC App provided reliable knowledge, information, and emotional support. Recommendations from participants included categorizing knowledge in the Library Module, recording videoconferences of mindfulness practice, and adding discussion sessions in the videoconference. Afterward, we optimized the MBC App to enhance the user experience accordingly.

Conclusions: The MBC App offers online mindfulness interventions specifically for BCSs in China. The preliminary quality assessment indicates that the MBC App may be a promising tool for delivering mindfulness interventions to BCSs.

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What is known?

- Breast cancer survivors (BCSs) often experience significant body image distress and stigma.

* Corresponding author.

E-mail address: Jieminzhu@xmu.edu.cn (J. Zhu).

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¹ Shuang Zheng and Wenhe Huang contributed equally to this study.

- Traditional interventions have shown promise in alleviating body image distress and stigma.
- Existing mobile applications for cancer patients often lack cultural specificity and fail to address the unique needs of Chinese BCSs.

What is new?

- This is the first Mindfulness Breast Care (MBC) App targeting body image distress and stigma for BCSs in China.
- The data shows that the MBC App has high functionality, aesthetics, information quality, and perceived impact, demonstrating the potential for integration into routine care to support BCSs.
- Participants indicate that the MBC App offers structured knowledge and emotional support and provides improvement suggestions such as content categorization, mindfulness video conferences being recorded, and access to expert consultations.

1. Introduction

Breast cancer is a global public health concern and the most commonly diagnosed cancer among women worldwide [1]. In China, the incidence of breast cancer is rapidly increasing. In 2022, 357,161 women in China were diagnosed with breast cancer, representing 15.6 % of all cancer cases among Chinese women [2]. Advancements in medical technology have led to gradually increasing survival rates for patients with breast cancer. In China, the 5-year relative survival rate is 83.2 %, and an increasing number of breast cancer survivors (BCSs) continue to live beyond cancer diagnosis [3]. BCSs are individuals who have completed primary treatment for breast cancer and survived long-term [4]. However, the diagnosis and treatment of breast cancer often result in lasting adverse effects on BCSs' physical and mental health, which can persist for years after treatment [5].

Common treatments for breast cancer include breast-conserving therapy with radiation and mastectomy with adjuvant chemotherapy. A breast cancer diagnosis often triggers fear, anxiety, and emotional instability, causing substantial psychological stress in patients [6]. Breast cancer treatments can significantly impact patients' physical appearance and be profoundly distressing, negatively affecting their physical, psychological, emotional, and overall quality of life [7]. Even post-treatment, these women continue to experience distressing symptoms, particularly related to fears of recurrence, death, and disability [8]. Consequently, the physical and emotional burdens caused by breast cancer diagnosis and treatments significantly influence patients' perceptions of their body image.

Body image is a multidimensional concept that refers to the mental image of the individual's body, reflecting the feeling of being oneself [9]. Surgeries are the most commonly used treatments for breast cancer, with each type causing varying degrees of physical damage to the female body image. In China, approximately 78 % of women with breast cancer undergo a mastectomy with or without reconstruction [10], compared with 35.5 % in the United States [11]. The complete or partial removal of the breast may alter a woman's body image and feminine identity [12]. Even when women undergo breast-conservative surgery, scars and disfigurement of the breast can affect their self-image [13]. After surgeries, patients commonly experience challenges such as upper limb lymphedema, muscle atrophy, and sensory disturbances around the surgical area, all of which can significantly negatively impact body image [12]. Body image distress frequently results in low self-esteem, leading to perceived stigma or shame [14].

Stigma is perceived as discrediting and can negatively affect the standing of individuals in society [15]. Over 80 % of BCSs experience stigma in China, with changes in body image being the most significant contributing factor [12]. Influenced by traditional Chinese culture, Chinese women are not willing to talk about their feelings and thoughts in public, especially regarding cancer-related issues [16,17]. Therefore, the barriers to self-expression contribute to the increased stigma experienced by BCSs [18]. Stigma can discourage BCSs from participating in care and may lead these individuals to reject the support of others and withdraw from social activities [19]. Social support plays a pivotal role in the recovery of BCSs. Positive social support can alleviate psychological stress, decrease body image distress and stigma, and improve quality of life [20]. Therefore, identifying effective interventions is crucial, given the significant impact of these factors on BCSs.

Various studies have explored strategies to address body image distress and stigma in BCSs. Exercise-based interventions, education, and psychosocial interventions have shown positive effects on reducing body image distress and stigma of BCSs [21,22]. Recently, mindfulness-based approaches have emerged as a distinct but increasingly popular method for supporting BCSs [23]. Compared to traditional interventions, mindfulness emphasizes present-moment awareness and self-compassion, which may address underlying emotional and cognitive processes not fully targeted by conventional methods, offering a holistic approach to reducing body image distress and stigma [24].

Mindfulness is a mental state characterized by a focused awareness of the present moment and acknowledging and accepting feelings, thoughts, and bodily sensations [23]. Based on meditation and self-awareness, mindfulness has been integrated into numerous therapeutic interventions, which have been proven to have significant effects on relieving cancer-related stigma and stress as well as enhancing quality of life [25]. However, because of the limited number of trained therapists, high costs, restricted flexibility, and time constraints, there remain challenges in providing face-to-face mindfulness intervention to BCSs [26]. The Internet may help overcome these obstacles, owing to its broad reach.

Several mobile apps have been developed to support cancer patients, including BCSs, by providing mindfulness or psychological support. For example, *Headspace*, a self-paced program that provides guided mindfulness meditation instructions, has improved mood and positive affect, reduced stress, enhanced general well-being, and increased mindfulness [27]. However, it does not address the unique cultural and psychological challenges faced by Chinese BCSs, particularly concerning body image distress and stigma. Additionally, many apps require separate downloads and installations, which can pose a barrier for some users. These limitations highlight the need for more tailored and accessible solutions for Chinese BCSs.

In 2023, mobile phone usage in China exceeded one device per person, with 107.9 million people using mobile phones to access the Internet [28]. WeChat, the largest free mobile platform in China, incorporates the miniapp as one of its functionalities, where easy accessibility and better flexibility can significantly improve coverage and reduce the cost of mindfulness therapy [29]. In addition, app-based interventions can provide a sense of anonymity, which may encourage individuals to participate more openly and comfortably, especially when addressing sensitive issues, such as stigma and body image distress [30]. Therefore, we developed and preliminarily assessed the quality of a Mindfulness Breast Care (MBC) App to address their body image distress and stigma.

2. Methods

This study involves two stages: the development of the MBC App and the quality assessment.

2.1. Development of the Mindfulness Breast Care App

2.1.1. Establishment of a research group

The first phase involved building a research group. Two nursing professors, two oncologists from two tertiary hospitals, two mindfulness psychologists, one software engineer, two master's students, and one yoga coach were approached, and subsequent meetings were organized. The research team constructed and mapped a timeline illustrating the key milestones. The responsibilities of each team member are listed (Appendix A).

2.1.2. Determination of the content of the Mindfulness Breast Care App

The content of the MBC App was determined under the conceptualization of mindfulness-based cognitive therapy (MBCT), which incorporates the mindfulness-based stress reduction theory (MBSR) with cognitive behavior therapy (CBT) [31]. MBCT applied CBT skills to practice MBSR [31]. According to MBCT, automatic negative thought patterns result in automatic negative behaviors. MBCT does not attempt to change the content of negative thinking; instead, it teaches patients to notice their thoughts when feelings emerge. MBCT applies meditation techniques to help patients tune into their mind and body's moment-to-moment awareness and accept thoughts as events in the mind. The repeated practice of observing with a non-judgmental attitude helps patients understand that their negative thoughts are not true. It encourages patients to develop the ability to allow distressing emotions, thoughts, and feelings to flow in and out, thereby altering the relationship with their thoughts. Finally, patients learn to remain connected to the current moment and live in the present, from which changes can occur [31,32].

MBCT guided the design of group-based skills training, including educational components, yoga exercises, and mindfulness practices, to help individuals with chronic disease [32–35]. Based on MBCT [32], three modules were designed in the MBC App: 1) Library, 2) Mindfulness Yoga, and 3) Mindfulness Practices (Fig. 1). The educational component module was defined as the "Library." The functionality of each module was clearly defined, and the objectives were aimed at reducing body image distress and stigma for BCS. Data from a previous study indicated that a 12-week online MBCT App was enough to improve psychological outcomes [36]. Thus, consensus was reached among the research team that a 12-week intervention was sufficient to test the effectiveness of the MBC App.

The topics of the Library module were formulated through

discussion among multidisciplinary oncology professionals in China. The content is primarily sourced from authoritative publications, such as *Mindfulness-Based Cognitive Therapy: Distinctive Features*, *China Breast Cancer Diagnosis and Treatment Guidelines (2021 Edition)*, and *Chinese Dietary Guidelines (2022 Edition)* [31,37,38]. All knowledge is credible, evidence-based, and sourced from authoritative publications, ensuring accuracy and reliability for users seeking trustworthy information.

Mindfulness Yoga was developed by a yoga coach and two mindfulness psychotherapists following the principles of *Mindfulness-Based Cognitive Therapy: Distinctive features* [31]. A review of yoga exercises indicates that online yoga is feasible and acceptable and may help manage symptoms associated with various diseases [39]. Hatha yoga integrates mindfulness into physical exercises such as stretching and sitting meditations [39]. Instead of judging their bodies, women are guided to observe their bodily sensations and be aware of their thoughts during mindfulness yoga. Hatha Yoga has been shown to have a beneficial effect on reducing anxiety and improving emotional well-being [39].

The book *Mindful Way Workbook: An 8-Week Program to Free Yourself from Depression and Emotional Distress* guides the development of the Mindfulness Practices module [40]. The book includes eight weeks of sessions with 14 audio clips. Two mindfulness psychotherapists had full communication and decided to separate two long sessions with several audio clips into four sessions. In our program, the automatic pilot session is divided into two sessions: autopilot and body scan. The moment-to-moment awareness session is separated into two other sessions: mindful walking and mindful movement. Further, two sessions have been added: questions and answers (Q&A) with experts and sharing your story sessions. In the Q&A with experts, participants may ask health-related questions they encounter, and breast specialists can provide corresponding advice. In the session of sharing your story, one BCS who had overcome distress related to altered body image and stigma may share her own story. Participants are also invited to share their concerns and receive suggestions or encouragement from peers.

2.1.3. Technical exploitation and maintenance of the Mindfulness Breast Care App

An Internet company undertook the MBC APP's technical exploitation and maintenance. The MBC APP's modification was accomplished by sharing the MBC App with potential users to gather feedback, collaborating with the IT company to implement improvements, and conducting further discussions with team members to refine the app.

2.2. Preliminary quality assessment of the mindfulness breast care app

2.2.1. Study design

A mixed-methods study design was applied, including assessing quality of the MBC App and interviewing for process evaluation.

2.2.2. Study setting and participants

This study was conducted at two university-affiliated hospitals. BCSs visit hospitals every three months for medical follow-up within the first two years, following the guidelines of breast cancer diagnosis and treatment (2021 edition, Cancer Association in China) [37]. Women aged ≥18 years were eligible to participate if they had been diagnosed with breast cancer, had completed surgery, chemotherapy, or radiotherapy and were ready to be discharged from the hospital, had access to the Internet via a mobile phone, were able to read and write Mandarin, and were not currently enrolled in a psychosocial support group. Women with other concurrent cancers or major psychiatric illnesses were

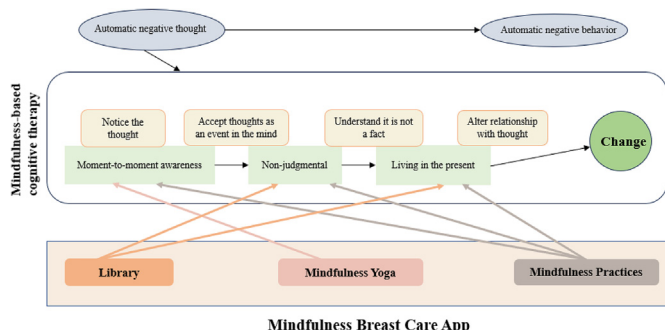


Fig. 1. The content of the three modules in the Mindfulness Breast Care App.

excluded. Ten eligible patients were recruited by a convenience sampling method.

2.2.3. Measures

2.2.3.1. Sociodemographic data. The collected sociodemographic data included age, marital status, current employment, cancer stage, type of surgery, chemotherapy, radiotherapy, endocrine therapy, and targeted therapies.

2.2.3.2. The evaluation of the Mindfulness Breast Care App. The quantitative evaluation of the MBC App was conducted using the Mobile App Rating Scale: User Version (uMARS), a tool designed to assess the quality of mobile health apps across six components: engagement, function, aesthetics, information quality, subjective quality, and perceived impact [41]. The average score ranges from 1 to 5, with higher scores representing higher quality. The uMARS has high internal consistency (Cronbach's α coefficient = 0.890) and internal reliability (intraclass correlation coefficient = 0.969) [41].

Moreover, the researchers conducted one-on-one telephone interviews with another five patients following the semi-structured interview guideline. The semi-structured interview guidelines were as follows: 1) How do you think the MBC App? 2) Which module do you like best/least in the MBC App? 3) What are the main benefits of the MBC App for you? 4) What advice do you have for the improvement of the MBC App? After the semi-structured interview, the MBC App was adjusted in a collaborative, consultative process with participant feedback and ideas to ensure optimal user experience.

2.2.4. Data collection

Data were collected from April 2022 to June 2022. After obtaining the ethical approvals from the participating hospital, BCSs were approached in the clinics with an explanation of the MBC App. After 12 weeks of access to the MBC App, five participants were given the uMARS online questionnaire to complete, and the researcher checked the authenticity and validity of the questionnaires upon their return. The other five participants were interviewed via telephone. The interviews lasted 5–20 min, and each was audio-recorded, transcribed, and summarized.

2.2.5. Data analysis

IBM SPSS 26.0 was used to analyze sociodemographic data in the form of frequency and percentage and calculate the mean and standard deviation (*SD*) for each subscale of uMARS. Inductive content analysis was employed to analyze the transcripts of the interviews. Immediately after the interview, the first author transcribed the audiotapes verbatim into transcripts. S. Zheng and S. Liu performed the initial coding independently. Any coding discrepancies were discussed among the research team to ensure consensus. The various codes were sorted into subcategories. Multiple subcategories were combined into categories. All researchers then discussed and reviewed the subcategories and categories until an agreement was reached. Two experts in qualitative research supervised the process of data analysis.

2.2.6. Ethical consideration

The quality evaluation adhered to the Declaration of Helsinki and received approval (XAHLL2022027 and XMY-2022KY025-06) from the ethics committees of the two university-affiliated hospitals. All participants provided written informed consent.

3. Results

3.1. Mindfulness Breast Care App

The MBC App has three modules: 1) Library, 2) Mindfulness Yoga, and 3) Mindfulness Practice. These modules are presented on the homepage (Appendix B).

The Library module provides educational materials, including information on body image distress, stigma sources, management strategies for body image and stigma, mindfulness information, healthy lifestyle tips, and follow-up information. To prevent BCSs from being overwhelmed by excessive information, only one topic is released each week, and a reminder message of new information is sent to the users (Appendix C).

The Mindfulness Yoga module provides 12 Hatha yoga videos for the BCSs to practice daily, consisting of breathing exercises, sitting meditation, stretching, yin yoga, hatha yoga, standing movements, sitting forward bend, yoga for pelvic muscles, yoga for breast care, standing forward bend, sun salutation, and deep relaxation. The research team validated the content of each module. One yoga video is released, and a reminder message is sent each week (Appendix C).

The Mindfulness Practice module offers 12 videoconferences of group-based mindfulness practice, including 1) an introduction to mindfulness and autopilot; 2) a body scan; 3) 10-min sitting meditation—mindfulness of the breath; 4) mindful walking; 5) mindful movement; 6) stretch and breath meditation; 7) 3-min breathing space; 8) 20-min sitting meditation; 9) working with difficulty meditation; 10) two ways of knowing; 11) Q&A with experts and 12) sharing your story (Appendix C).

In the MBC App background management thread, researchers can use the participants' mobile phone numbers to create usernames and corresponding passwords (changeable later). Participants can search for the MBC App on their mobile WeChat platform, scan the QR code to download it, and then log in with their username. Furthermore, the MBC background management thread can track the usage duration and frequency of the entire app and each module for every participant (Appendix D).

3.2. Characteristics of the participants

A total of ten BCSs were enrolled in the study, with a mean age of 46.6 years. The participants were diagnosed with stage II ($n = 7$), followed by stage I ($n = 2$) and stage III ($n = 1$). Six participants underwent mastectomy, two underwent breast-conserving surgery, and two underwent mastectomy and breast reconstruction (Appendix E).

3.3. Preliminary findings on the quality of Mindfulness Breast Care App

The mean subscale scores for MBC App quality were 3.72 ± 0.94 for engagement, 4.10 ± 0.34 for functionality, 3.93 ± 0.55 for aesthetics, 4.10 ± 0.72 for information quality, 3.87 ± 0.77 for app subjective quality, and 4.03 ± 0.96 for perceived impact. The overall mean uMARS score for MBC App was 3.96 ± 0.78 .

3.4. Preliminary findings on the qualitative interview

Five patients were interviewed for process evaluation. According to the qualitative inductive content analysis method, the researchers finally identified two main categories, including 1) the benefits of the MBC App and 2) the improvement suggestion of the MBC App.

3.4.1. Theme 1: benefits of the Mindfulness Breast Care App

3.4.1.1. *Provision of knowledge and information on breast cancer treatment and intervention.* Most participants mentioned that the knowledge provided in the Library module was a beneficial supplement to their treatment and intervention. The Library module provided specialized knowledge tailored to the course of disease and treatments:

“The MBC App provides valuable knowledge on diet, sleep, and related aspects of the healing process. It offers a scientifically informed guide to diet, exercise, emotions, and sleep.” (P7)

“The Library module in the MBC App is highly useful. Upon discharge, we hope to seek professional consultation and explanations for specialized issues. The MBC App allows us to access information on specific topics of interest.” (P10)

3.4.1.2. *Emotional regulation.* The majority of the interviewees considered that the MBC App relieved their distress and contributed to reaching a peaceful mind:

“In the MBC App, the mentors help us adjust our mindset, which is highly beneficial. She supervised us in scanning our bodies and meditation. After each session, I always feel much better.” (P8)

“It enables us to learn more about breast cancer and my body promptly. The discussions, lectures, and communication in the groups are valuable, helping to calm our minds.” (P9)

3.4.2. Theme 2: improvement suggestion of the Mindfulness Breast Care App

Based on their experience with the MBC App, some interviewees provided suggestions on how to improve the MBC App.

3.4.2.1. *Categorized knowledge in the Library module.* Some interviewees expressed a desire for the Library to be enriched and updated with more content, and the content should be sorted out into different categories:

“The content in the Library is special and inspirational, but I hope there can be more comprehensive insights on medication and treatment. I hope the headings can be broken down in more detail to make them more intuitive and easy to understand at a glance.” (P6)

“Could the content in the Library be more comprehensive? For example, by adding some information on precautions regarding prognosis.” (P7)

3.4.2.2. *Recorded the videoconferences of mindfulness practice.* One interviewee reported the need to record video conferences and add one function to replay such videos:

“I hope the weekly meeting videos are available for replay. If I cannot attend the weekly meetings, I would like to access the videos in the Mindfulness Practice and use them for individual practice.” (P6)

3.4.2.3. *Added discussion session at the end of each videoconference.* One interviewee indicated that they would like to have a discussion session at the end of each videoconference to answer questions about the problems they encountered in their daily practice of mindfulness:

“Can we have a period (5-10 min) before or after each session where mindfulness psychotherapists could address the questions encountered in our daily practice of mindfulness?” (P7)

3.5. Optimizing user experience

To ensure optimal user experience, refinement processes were conducted in response to comments from the semi-structured interview. The Library module ensured abundant digestible information and educational materials, which were categorized into different topics and uploaded accordingly. Following each videoconference, the standard mindfulness practice audio was updated in the Library module for the participants to practice at home. At the end of each videoconference, a brief discussion session was held to allow participants to discuss their questions.

4. Discussion

Given the high demand for information [42,43], BCSs often face challenges finding reliable resources online due to the overwhelming amount of mixed-quality content [44]. The MBC App's superiority lies in the credibility of the content, particularly in the Library module, where BCSs can find trustworthy information.

A systematic review indicated that online interventions are the most effective among the various psychosocial interventions for BCSs [21], highlighting the importance of developing online intervention strategies. Although existing surveys suggest internet interventions are as effective as face-to-face ones [45], only limited studies have used online mindfulness interventions. The online approach of the MBC App enables BCSs to learn and practice mindfulness yoga wherever and whenever they need it. The 12 weekly videoconferences in the Mindfulness Practice module offer ongoing guidance, which can help patients raise their moment-to-moment awareness and develop a non-judgmental attitude.

Preliminary uMARS data for the MBC App raises important reflective questions and considerations for the future. Each subscale score provides insight into the participants' preferences and indicates how effectively the MBC App addresses their perceived needs. The results showed high functionality, aesthetics, information quality, and perceived impact scores, suggesting the app is useable, enjoyable, credible, and highly relevant to BCSs' medical conditions. The subjective quality was 3.87 out of 5, higher than the mHealth scores in other studies [46,47], indicating that participants may be willing to recommend the app to others or pay for it [41]. However, the engagement score was the lowest, suggesting that the MBC App still needs to improve its entertainment and interactivity. Participants may expect more interesting content and interactive features to stimulate repeat use, despite these features potentially increasing the design and technical complexity of the app [46].

The qualitative interview highlights the users' overall satisfaction with the MBC App. Participants reported that the MBC App provides structured knowledge and emotional support. Participants in the study emphasize the usefulness of the Library module, particularly in providing structured, credible, and accessible knowledge tailored to their needs. This finding aligns with previous research indicating that access to reliable health knowledge is critical in patient empowerment and psychological well-being [43]. Additionally, some participants stated that the MBC App alleviated psychological distress and helped them achieve a peaceful mind. This positive experience can be explained by MBCT, which employs meditation to enhance present-moment awareness, thereby reducing distress and promoting inner peace [32].

The qualitative interview provided valuable suggestions for the

optimization of the MBC App. Participants suggested that the Library module provides more clearly categorized content. In response, we reorganized the Library module by classifying and structuring the content, which may reduce cognitive load, improve information retrieval efficiency, and boost users' engagement [42]. Additionally, in case the participants missed live mindfulness practice videoconferences, we recorded the videoconferences and updated them in the Library module, which could enhance MBC App flexibility by allowing users to review and practice at their convenience. This improvement aligns with existing research, demonstrating that flexible access can significantly improve user engagement, particularly in health interventions [21]. Some users also requested expert consultations. They valued the tailored advice from experts. In response, we implemented a discussion session at the end of each videoconference, which offered real-time, personalized guidance from psychotherapists, thereby improving the overall effectiveness of mindfulness practice [48].

5. Limitations

This study only recruited 10 participants for a preliminary quality evaluation, leading to a small sample size and limited representativeness. Despite the limitation, the study primarily aimed to assess the quality of the MBC App's design and content and make corresponding improvements for future empirical research on its app. A full-scale multicenter randomized controlled trial is currently underway to explore the effectiveness and cost-effectiveness of the MBC App. This trial will further demonstrate the potential of the MBC App to be incorporated into routine care to support BCSs.

6. Conclusions

MBC App is the first app that offers online mindfulness interventions specifically for BCSs in China, including Library, Mindfulness Yoga, and Mindfulness Practices. The Library module assists BCSs in cultivating nonjudgmental attitudes and adopting healthy lifestyle practices. The Mindfulness Yoga module enables BCSs to engage in moment-to-moment awareness practice. The Mindfulness Practice module encourages BCSs to transition from moment-to-moment awareness to nonjudgmental attitudes and live in the present. The three modules complement each other to help BCSs reduce body image distress and stigma. The uMARS data indicates that the MBC App received high scores in functionality, aesthetics, information quality, and perceived impact, suggesting it may be a valuable tool for delivering mindfulness interventions to BCSs. The qualitative research results indicate that the MBC App provides structured knowledge and emotional support. Recommendations from participants included categorizing knowledge in the Library module, recording videoconferences of mindfulness practice, and adding discussion sessions in the videoconference. Based on these suggestions, we optimized the MBC App accordingly. A multicenter randomized controlled trial will be conducted to investigate the effectiveness and cost-effectiveness of the MBC App.

CRedit authorship contribution statement

Shuang Zheng: Methodology, Investigation, Project administration, Data curation, Writing – original draft. **Wenhe Huang:** Formal analysis, Investigation, Writing – original draft. **Xueqin Zhang:** Methodology, Investigation, Writing – original draft. **Ying Hua:** Methodology, Investigation, Data curation, Formal analysis, Writing – original draft. **Sally Chan:** Investigation, Supervision. **Shengjie Liu:** Methodology, Data curation, Project administration. **Yujing Zhong:** Methodology, Data curation. **Xiaoying Jiang:** Methodology, Writing – review & editing, Supervision. **Jiemin**

Zhu: Conceptualization, Validation, Investigation, Project administration, Data curation, Formal analysis, Funding acquisition, Writing – review & editing, Supervision.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Declaration of competing interest

The authors declare that they have no competing interests.

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Appendices. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijnss.2025.04.007>.

References

- [1] Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin* 2024;74(3): 229–63. <https://doi.org/10.3322/caac.21834>.
- [2] World Health Organization, Today Cancer. Absolute numbers, Incidence, Both sexes, in 2022, China, Top 15 cancer sites. Retrieved from, https://gco.iarc.fr/today/en/dataviz/bars?mode=cancer&group_populations=0&key=total&populations=160&sexes=0&age_end=17&multiple_populations=0. [Accessed 18 February 2025].
- [3] Allemani C, Matsuda T, Di Carlo V, Harewood R, Matz M, Nikšić M, et al. Global surveillance of trends in cancer survival 2000–14 (CONCORD-3): analysis of individual records for 37 513 025 patients diagnosed with one of 18 cancers from 322 population-based registries in 71 countries. *Lancet* 2018;391(10125):1023–75. [https://doi.org/10.1016/S0140-6736\(17\)33326-3](https://doi.org/10.1016/S0140-6736(17)33326-3).
- [4] Kelly KM, Shah N, Shedlosky-Shoemaker R, Porter K, Agnese D. Living post treatment: definitions of those with history and no history of cancer. *J Cancer Surviv* 2011;5(2):158–66. <https://doi.org/10.1007/s11764-010-0167-1>.
- [5] Singleton AC, Raeside R, Partridge SR, Tat-Ko J, Che Mun Sum S, Hyun KK, et al. Supporting breast cancer survivors via text messages: reach, acceptability, and utility of EMPOWER-SMS. *J Cancer Surviv* 2022;16(6):1165–75. <https://doi.org/10.1007/s11764-021-01106-7>.
- [6] Tao L, Xiang YP, Zeng XH, Fu L, Li JY, Chen H. Psychological-distress factors in patients with breast cancer: a qualitative meta-synthesis. *J Clin Nurs* 2024;33(12):4843–59. <https://doi.org/10.1111/jocn.17532>.
- [7] Hoyle E, Kilbreath S, Dylke E. Body image and sexuality concerns in women with breast cancer-related lymphedema: a cross-sectional study. *Support Care Cancer* 2022;30(5):3917–24. <https://doi.org/10.1007/s00520-021-06751-3>.
- [8] Yang Y, Sun HW, Luo X, Li WG, Yang F, Xu WJ, et al. Network connectivity between fear of cancer recurrence, anxiety, and depression in breast cancer patients. *J Affect Disord* 2022;309:358–67. <https://doi.org/10.1016/j.jad.2022.04.119>.
- [9] Rodrigues ECG, Neris RR, Nascimento LC, de Oliveira-Cardoso ÉA, Dos Santos MA. Body image experience of women with breast cancer: a meta-synthesis. *Scand J Caring Sci* 2023;37(1):20–36. <https://doi.org/10.1111/scs.13102>.
- [10] Yang BL, Ren GS, Song EW, Pan D, Zhang J, Wang YS, et al. Current status and factors influencing surgical options for breast cancer in China: a nationwide cross-sectional survey of 110 hospitals. *Oncologist* 2020;25(10):e1473–80. <https://doi.org/10.1634/theoncologist.2020-0001>.
- [11] Kummerow KL, Du LP, Penson DF, Shyr Y, Hooks MA. Nationwide trends in mastectomy for early-stage breast cancer. *JAMA Surg* 2015;150(1):9–16. <https://doi.org/10.1001/jamasurg.2014.2895>.
- [12] Jin RQ, Xie TT, Zhang LJ, Gong N, Zhang JE. Stigma and its influencing factors among breast cancer survivors in China: a cross-sectional study. *Eur J Oncol*

- Nurs 2021;52:101972. <https://doi.org/10.1016/j.ejon.2021.101972>.
- [13] Jakobsen K, Magnus E, Lundgren S, Reidunsdatter RJ. Everyday life in breast cancer survivors experiencing challenges: a qualitative study. *Scand J Occup Ther* 2018;25(4):298–307. <https://doi.org/10.1080/11038128.2017.1335777>.
- [14] Amini-Tehrani M, Zamanian H, Daryaafzoon M, Andikolaei S, Mohebbi M, Imani A, et al. Body image, internalized stigma and enacted stigma predict psychological distress in women with breast cancer: a serial mediation model. *J Adv Nurs* 2021;77(8):3412–23. <https://doi.org/10.1111/jan.14881>.
- [15] Fife BL, Wright ER. The dimensionality of stigma: a comparison of its impact on the self of persons with HIV/AIDS and cancer. *J Health Soc Behav* 2000;41(1):50–67.
- [16] Wang L, Geng X, Ji L, Lu G, Lu Q. Treatment decision-making, family influences, and cultural influences of Chinese breast cancer survivors: a qualitative study using an expressive writing method. *Support Care Cancer* 2020;28(7):3259–66. <https://doi.org/10.1007/s00520-019-05161-w>.
- [17] Cui C, Wang L. Mediating effect of social constraints in the association between stigma and depressive symptoms in Chinese breast cancer patients. *BMC Psychiatry* 2024;24(1):923. <https://doi.org/10.1186/s12888-024-06379-7>.
- [18] Tang W-z, Yusuf A, Jia K, Iskandar YHP, Mangantig E, Mo X-s, et al. Correlates of stigma for patients with breast cancer: a systematic review and meta-analysis. *Support Care Cancer* 2022;31(1):55. <https://doi.org/10.1007/s00520-022-07506-4>.
- [19] Jiang N, Zhang YX, Zhao J, Shi HY, Wang T, Jin W, et al. The mediator role of stigma in the association of mindfulness and social engagement among breast cancer survivors in China. *Support Care Cancer* 2022;30(6):5007–15. <https://doi.org/10.1007/s00520-022-06882-1>.
- [20] Singh Shrestha J, Shrestha A, Sapkota A, Sharma R, Shrestha S, Shrestha S, et al. Social support, quality of life and mental health status in breast cancer patients. *Cancer Rep Rev* 2017;1(2):1–5. <https://doi.org/10.15761/crr.1000107>.
- [21] Lewis-Smith H, Diedrichs PC, Rumsey N, Harcourt D. Efficacy of psychosocial and physical activity-based interventions to improve body image among women treated for breast cancer: a systematic review. *Psychooncology* 2018;27(12):2687–99. <https://doi.org/10.1002/pon.4870>.
- [22] Zheng S, Liu SJ, Yang QM, Chan S, Huang WH, Jiang XY, et al. The effectiveness of interventions to reduce cancer-related stigma: an integrative review. *J Clin Nurs* 2024;33(7):2438–55. <https://doi.org/10.1111/jocn.17014>.
- [23] Bishop SR, Lau M, Shapiro S, Carlson L, Anderson ND, Carmody J, et al. Mindfulness: a proposed operational definition. *Clin Psychol Sci Pract* 2004;11(3):230–41. <https://doi.org/10.1093/clipsy.bph077>.
- [24] Chayadi E, Baes N, Kiroopoulos L. The effects of mindfulness-based interventions on symptoms of depression, anxiety, and cancer-related fatigue in oncology patients: a systematic review and meta-analysis. *PLoS One* 2022;17(7):e0269519. <https://doi.org/10.1371/journal.pone.0269519>.
- [25] Kabat-Zinn J. Mindfulness-based interventions in context: past, present, and future. *Clin Psychol Sci Pract* 2003;10(2):144–56. <https://doi.org/10.1093/clipsy.bpg016>.
- [26] Wang Q, Zhang C, Zhang Z, Chen R, Liu L, Zhang X, et al. The effect of mindful psychological intervention on stigma and adaptation levels in patients with gynecological cancer. *J Nurs* 2020;35(13):71–3. <https://doi.org/10.3870/j.issn.1001-4152.2020.13.071> (in Chinese).
- [27] Rung AL, Oral E, Berghammer L, Peters ES. Feasibility and acceptability of a mobile mindfulness meditation intervention among women: intervention study. *JMIR Mhealth Uhealth* 2020;8(6):e15943. <https://doi.org/10.2196/15943>.
- [28] China Marketing Corporation (CMC). China internet users data. Retrieved from, <https://chinamarketingcorp.com/blog/2023-china-internet-user-data/>. [Accessed 18 February 2025].
- [29] Cillessen L, van de Ven MO, Compen FR, Bisseling EM, van der Lee ML, Speckens AE. Predictors and effects of usage of an online mindfulness intervention for distressed cancer patients: usability study. *J Med Internet Res* 2020;22(10):e17526. <https://doi.org/10.2196/17526>.
- [30] Jin YC, Zhang Z, Zheng PX, An JX. Telepsychology: applications, advantages, and challenges. *Adv Psychol Sci* 2022;30(1):141–56.
- [31] Crane R. Mindfulness-based cognitive therapy: distinctive features. London: Routledge; 2017. <https://doi.org/10.4324/9781315627229>.
- [32] Rizwana A. Mindfulness-based cognitive therapy for depression: a review. *Int J Sci Healthc Res* 2020;5(4):77–84.
- [33] Musial F, Büssing A, Heusser P, Choi KE, Ostermann T. Mindfulness-based stress reduction for integrative cancer care: a summary of evidence. *Forsch Komplementmed* 2011;18(4):192–202. <https://doi.org/10.1159/000330714>.
- [34] Alsubaie M, Abbott R, Dunn B, Dickens C, Keil TF, Henley W, et al. Mechanisms of action in mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR) in people with physical and/or psychological conditions: a systematic review. *Clin Psychol Rev* 2017;55:74–91. <https://doi.org/10.1016/j.cpr.2017.04.008>.
- [35] Pascoe MC, Thompson DR, Ski CF. Yoga, mindfulness-based stress reduction and stress-related physiological measures: a meta-analysis. *Psychoneuroendocrinology* 2017;86:152–68. <https://doi.org/10.1016/j.psyneuen.2017.08.008>.
- [36] Kahlmann V, Moor CC, van Helmond SJ, Mostard RLM, van der Lee ML, Grutters JC, et al. Online mindfulness-based cognitive therapy for fatigue in patients with sarcoidosis (TIREd): a randomised controlled trial. *Lancet Respir Med* 2023;11(3):265–72. [https://doi.org/10.1016/S2213-2600\(22\)00387-3](https://doi.org/10.1016/S2213-2600(22)00387-3).
- [37] Chinese Anti-Cancer Association—Committee of Breast Cancer Society. Breast cancer diagnostic and treatment (2021 edition). *China Oncology* 2021;31(10):954–1040. <https://doi.org/10.19401/j.cnki.1007-3639.2021.10.013> (in Chinese).
- [38] Chinese Nutrition Society. Dietary guidelines for Chinese residents (2022). Beijing: Chinese Nutrition Society; 2022. ISBN: 9787117314046.
- [39] Brosnan P, Nauphal M, Tompson MC. Acceptability and feasibility of the online delivery of hatha Yoga: a systematic review of the literature. *Complement Ther Med* 2021;60:102742. <https://doi.org/10.1016/j.ctim.2021.102742>.
- [40] Teasdale J, Williams M, Segal Z. The mindful way Workbook: an 8-week program to free Yourself from depression and emotional distress. New York: Guilford Press; 2014. ISBN: 9781462508143.
- [41] Zhang C, Li X, Li X, Wu H. Cross-cultural adaptation and validation of the Chinese version of the User Version of the Mobile Application Rating Scale (uMARS). *Chin J Mod Nurs* 2020;26(19):2608–12. <https://doi.org/10.3760/cma.j.cn115682-20190806-02814> [in Chinese].
- [42] Halkett GKB, Kristjanson LJ, Lobb E, Little J, Shaw T, Taylor M, et al. Information needs and preferences of women as they proceed through radiotherapy for breast cancer. *Patient Educ Couns* 2012;86(3):396–404. <https://doi.org/10.1016/j.pec.2011.05.010>.
- [43] Zhu JM, Ebert L, Chan SW. Integrative review on the effectiveness of Internet-based interactive programs for women with breast cancer undergoing treatment. *Oncol Nurs Forum* 2017;44(2):E42–54. <https://doi.org/10.1188/17.ONF.E42-E54>.
- [44] Almoajel A, Alshamrani S, Alyabisi M. The relationship between e-health literacy and breast cancer literacy among Saudi women. *Front Public Health* 2022;10:841102. <https://doi.org/10.3389/fpubh.2022.841102>.
- [45] Cruz C, Orchard K, Shoemaker EZ, Hilty DM. A survey of residents/fellows, program directors, and faculty about telepsychiatry: clinical experience, interest, and views/concerns. *J Technol Behav Sci* 2021;6(2):327–37. <https://doi.org/10.1007/s41347-020-00164-5>.
- [46] Wan SW, Chong CS, Toh EL, Lim SH, Loi CT, Lew YFH, et al. A theory-based, multidisciplinary approach to cocreate a patient-centric digital solution to enhance perioperative health outcomes among colorectal cancer patients and their family caregivers: development and evaluation study. *J Med Internet Res* 2021;23(12):e31917. <https://doi.org/10.2196/31917>.
- [47] Lambrecht A, Vuillerme N, Raab C, Simon D, Messner EM, Hagen M, et al. Quality of a supporting mobile app for rheumatic patients: patient-based assessment using the user version of the mobile application scale (uMARS). *Front Med* 2021;8:715345. <https://doi.org/10.3389/fmed.2021.715345>.
- [48] Penedo FJ, Oswald LB, Kronenfeld JP, Garcia SF, Cella D, Yanez B. The increasing value of eHealth in the delivery of patient-centred cancer care. *Lancet Oncol* 2020;21(5):e240–51. [https://doi.org/10.1016/S1470-2045\(20\)30021-8](https://doi.org/10.1016/S1470-2045(20)30021-8).